Iowa Farm Science

Volume 13 | Number 11 Article 4

5-1959

Green Manures or Fertilizer Nitrogen for Corn?

F. C. Stickler
Iowa State College

I. J. Johnson
Iowa State College

W. D. Shrader
Iowa State College

H. E. Thompson
Iowa State College

formed than the younger persons. But, in the same age group, persons receiving retirement or survivors' payments were better informed than those not receiving such payments.

Information Sources: Farm people have used a wide variety of sources of information about OASI. The most widely used sources are magazines, newspapers, tax consultants, neighbors and friends, and social security representatives, in that order of importance.

The most frequently used sources, however, aren't always the best sources. Magazines and newspapers apparently are good sources —at least those who used these sources most had better-than-average knowledge about the program. On the other hand, tax consultants, neighbors and friends apparently aren't such good sources. Persons with the highest scores were those who got their information from the OASI representative, a social security pamphlet or their county extension director. But there weren't many of these people.

Information Wanted: Only 50 percent of the farm operators and 55 percent of the landlords said they'd like more information. In this group, most persons wanted information about how to figure or how to increase benefits—"get them high enough to live on." Only 6 percent of the landlords were interested in more details on how a landlord can participate, and only 4 percent were more interested in information on the conditions under which they should pay the tax. This is a surprisingly small proportion considering the complex requirements of the law for landlord participation. None were interested in more information on survivors' benefits.

What It Means: The OASI program is no doubt here to stay, and most of the people we questioned seemed to approve of it. Yet many have incomplete knowledge of the program. Older persons especially need more information.

If you're interested in learning more about OASI and how it affects you, the OASI representative who visits your county regularly is the best source. The next best would be to obtain copies of pamphlets published by the Social Security Administration, or you may ask your county extension director for copies. Your post office can furnish the address of the district social security office and the schedule of visits of the district OASI representative.

Legume Green Manures or Fertilizer Nitrogen for CORN?

How much nitrogen does a legume green-manure crop contribute to the soil? What influence does it have on the yields of the following corn crop? How does this compare with side-dressed applications of fertilizer nitrogen?

by F. C. Stickler, I. J. Johnson, W. D. Shrader and H. E. Thompson

THE SOURCE of nitrogen for corn on level productive soils is one of the most important crop management decisions facing farmers today. And this decision involves the relative or comparative values of nitrogen from legumes as green manures and from commercial fertilizers.

In this article, we'll be concerned only with nitrogen from legumes managed as *green manures*—legumes seeded with an oats companion crop and plowed under late in the fall of the seeding year or early the next spring. We're *not* dealing with the nitrogen contributions of legumes used for hay or pasture.

In attempting to determine the relative values of legume green manure and fertilizer nitrogen, there are three important questions:

● *"How much nitrogen is contained in various legumes and legume mixtures in the fall of the seeding year?"* Of special interest here is the performance of different legumes grown in mixtures as compared with their production when grown alone. Remember that we're

I. J. JOHNSON, W. D. SHRADER and H. E. THOMPSON are all members of the agronomy staff at Iowa State College. F. C. STICKLER, formerly at Iowa State College, is now located at Kansas State College.

dealing with *all* of the nitrogen contained in the legumes—not just with the nitrogen added to the soil from the air by the bacteria in legume nodules. About half to two-thirds of the total nitrogen contained in the legumes actually comes from the air. The rest comes from the soil.

● *"What influence or effects do these legumes and legume mixtures have on following corn yields?"*

● *"What is the value of nitrogen contained in* legume green manures *measured in terms of* fertilizer nitrogen?"

To answer these questions, we've conducted experiments at the Clarion-Webster Experimental Farm at Kanawha in the cash-grain area of the state. The comparative values of legume and fertilizer nitrogen are of utmost importance on many farms in this and other grain-producing areas.

In April of the 3 years, 1955, 1956 and 1957, we seeded five legumes alone and in various mixtures. Some of the plots were also seeded with oats without legumes so that fertilizer nitrogen could be side-dressed on the following corn crop as opposed to receiving nitrogen from the legumes plowed down.

Legumes used were Madrid (biennial) sweetclover, African alfalfa (a nonhardy southern variety), Ranger alfalfa, Kenland red clover and Ladino white clover. The oats crop on all plots was fertilized adequately with phosphorus and potassium and was combined at maturity. The tops and roots of the legumes were harvested in early October. Roots were dug to a maximum depth of 2½ feet. The amount of nitrogen contained in the various legumes was determined by chemical analyses.

How Much Nitrogen?

The answers to the first question from our experiments are summarized in table 1. It shows the pounds of nitrogen produced per acre by the different legumes and mixtures.

Sweetclover was outstanding in terms of nitrogen production when compared with the other legumes grown alone or in mixtures. Its average yield of nearly 160 pounds of nitrogen (including both tops and roots) per acre was 60 percent greater than that of African alfalfa and more than twice that of Ranger alfalfa or red clover.

Ladino clover was consistently the lowest nitrogen yielder in these tests. It has, however, been shown to perform more favorably in years of greater rainfall.

Of special importance is the fact that the nonhardy alfalfa, African, outyielded the hardy variety, Ranger. Thus, for *green manuring* purposes, the southern nonhardy alfalfas may be better than a hardy variety such as Ranger. Also, seed of the southern types is readily available, and the seed cost usually is less than for the hardy types.

Though 13 mixtures were included in our tests, only those of "key" importance are listed in table 1. We noted several things with regard to the performance of the mixtures.

First, as shown in table 1, the green manure mixtures didn't yield as well as Madrid sweetclover grown alone. Second, sweetclover contributed a major portion of the nitrogen in the mixtures in which it was included. An extreme case was the Madrid sweetclover-Ladino combination in which 96 percent of the total dry matter was contributed by the sweetclover. In mixtures containing three or four legumes, sweetclover contributed about 70 percent of the total dry matter.

A third important finding was that mixtures containing Madrid sweetclover consistently outyielded those not containing this legume, though not all of these comparisons are summarized in table 1.

Effect on Corn . . .

The second question relating to the relative values of legume and fertilizer nitrogen involves the influence of the two sources of nitrogen on following corn yields. We mentioned earlier that certain plots weren't seeded to legumes but to oats only. These plots were used for side-dressing corn the following year at rates of 0 (check), 25, 50, 75 and 100 pounds of fertilizer nitrogen per acre.

These plots, thus, gave us information on the yield responses from fertilizer nitrogen and provided a "yardstick" for comparing the values of legume and fertilizer nitrogen.

The grain yields from three first-year corn crops and two second-year crops are shown in table 2. A good yield response was obtained from 25 pounds per acre of fertilizer nitrogen. This large gain of 20 bushels from 25 pounds of fertilizer nitrogen may have been the result of poor soil management on the land in the past and of a higher plant population (16,000 stalks per acre) than the check plot could support.

The top yield was obtained from an application of 100 pounds of fertilizer nitrogen, with the 50-

TABLE 1. Average amounts of dry matter and nitrogen production in tops and roots of 11 legume green manures grown at Kanawha, Iowa, 1955-57.

Legume or mixture	Dry matter (lbs./A.) Tops	Roots	Total	Nitrogen yield (lbs./A.)	Percent of sweetclover in mixture
Legumes grown alone:					
Madrid sweetclover	3,084	2,864	5,948	159	.....
African alfalfa	2,213	1,524	3,737	97	.....
Ranger alfalfa	1,669	1,273	2,942	77	.....
Kenland red clover	2,006	549	2,555	65	.....
Ladino clover	1,468	309	1,777	47	.....
Mixtures of two legumes:					
Madrid, Kenland	2,617	2,150	4,767	128	89
Madrid, Ranger	2,462	2,303	4,765	125	77
Madrid, Ladino	2,282	2,025	4,307	113	96
Mixtures of three legumes:					
Madrid, African, Kenland	2,616	2,157	4,773	126	70
Madrid, African, Ladino	2,704	2,216	4,920	129	69
Mixture of four legumes:					
Madrid, African, Kenland, Ladino	2,376	1,943	4,319	114	68

and 75-pound applications giving intermediate responses.

First-year corn following legumes grown alone ranged from 74 bushels per acre following Ranger alfalfa to 102 bushels per acre following sweetclover. This compares with the yield of the check (no nitrogen from either source) of 66 bushels per acre.

Available soil moisture didn't limit yields as greatly in 1957 and 1958 as in 1956. Also in 1957 and 1958, we obtained information on second-year corn to which no additional nitrogen was applied. Thus, the yield differences for second-year corn were due to carryover or residual nitrogen from either legume or fertilizer sources.

The increases in corn yield due to carryover nitrogen ranged from 8 to 37 bushels per acre. It's evident, therefore, that the total effect of legume or fertilizer nitrogen isn't obtained in 1 year.

In Terms of Value . . .

The third question concerning the relative values of legume and fertilizer nitrogen is measured in terms of fertilizer nitrogen. Thus, the fertilizer nitrogen "equivalent" of a certain legume is merely the amount of fertilizer nitrogen (lbs./A.) required to produce a corn yield identical to that produced by the legume in question.

If a particular green manure, for example, produced a corn yield identical to that produced by 25 pounds of fertilizer nitrogen per acre, then the fertilizer nitrogen equivalent of that legume would be 25 pounds per acre.

For first-year corn, Madrid sweetclover had a fertilizer equivalent of 100 pounds per acre. That is, plowing under a green manure crop of sweetclover resulted in a corn yield the next year identical to that which would be produced by 100 pounds per acre of side-dressed nitrogen. The fertilizer nitrogen equivalents of the other four legumes in the first-year corn experiments were less than 50 pounds per acre. African and Ranger alfalfa were equivalent to 50 and 8 pounds, respectively, of fertilizer nitrogen per acre.

The fertilizer nitrogen equivalents were also determined for residual or carryover nitrogen for second-year corn in 1957 and 1958. The residual responses to nitrogen contained in Madrid sweetclover and African alfalfa were equivalent to those of 78 and 81, respectively, pounds of residual fertilizer nitrogen per acre. The response of second-year corn following Ranger alfalfa was also equivalent to that of 78 pounds of fertilizer nitrogen.

TABLE 2. Average corn yields following legumes, plowed under and from side-dressing with nitrogen fertilizer, Kanawha, Iowa, 1956-58.

Nitrogen treatment	First-year, 1956-58		Second-year, 1957-58	
	Corn yield (bu./A.)	Fertilizer nitrogen equivalent (lbs./A.)	Corn yield (bu./A.)	Fertilizer nitrogen equivalent (lbs./A.)
Legumes grown alone:				
Madrid sweetclover	102	100	80	78
African alfalfa	93	50	81	81
Ranger alfalfa	74	8	80	78
Kenland red clover	83	22	64	19
Ladino clover	76	12	71	31
Mixtures of two legumes:				
Madrid, Kenland	98	68	81	81
Madrid, Ranger	89	34	89	93
Madrid, Ladino	95	55	84	86
Mixtures of three legumes:				
Madrid, African, Kenland	89	73	85	87
Madrid, African, Ladino	99	34	80	78
Mixture of four legumes:				
Madrid, African, Kenland, Ladino	98	68	81	81
No legumes:				
Check yields (no nitrogen from either source)	66	.....	56	.....
25 lbs., fertilizer N	86	.....	66	.....
50 lbs., fertilizer N	93	.....	78	.....
75 lbs., fertilizer N	99	.....	79	.....
100 lbs., fertilizer N	102	.....	93	.....

Altogether . . .

Considering our findings as a whole, it's evident that legumes produced good corn yield responses but that top corn yields can also be obtained from fertilizer nitrogen. Generally the nitrogen contained in legumes was less efficient than fertilizer nitrogen. This could be expected, however, since only part (perhaps a half to two-thirds) of the nitrogen contained in legumes was actually added to the soil from the atmosphere.

Thus, on relatively level soils (like those in the Clarion-Webster soil association) it appears that legume green manures *may* be a more costly source of nitrogen for corn production than fertilizer nitrogen from two standpoints: First, the nitrogen contained in legumes is less efficient than that from fertilizer nitrogen. Second, a relatively high-profit corn or soybean crop must be sacrificed to establish the legumes with a low-profit oats crop.

In some cases, however, it may still be desirable to produce part of the nitrogen needed by the corn crop in the form of legume green manures. If so, there's the question of which legume or mixture is best.

Our results showed that biennial sweetclover was superior both in terms of nitrogen production and in corn yields the following year. But there are two important disadvantages in using sweetclover alone as a green manure. First, it's necessary to control the sweetclover weevil through the use of an insecticide such as dieldrin or heptachlor. And, clipping the oat stubble when necessary for weed control decreases the nitrogen production of sweetclover because of its poor recovery after clipping.

Because of these disadvantages, we believe that a mixture would be best in most instances. Though nitrogen production may be somewhat less, a mixture spreads the chances of getting a good stand among several legumes. A mixture of 5 pounds biennial sweetclover and 5 pounds of southern alfalfa or 5 pounds of medium red clover per acre is suggested.